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## A New Species of *Hydrophyllum* from the Ouachita Mountains of Arkansas

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In early May of 1979, during some fieldwork in the Ouachita Mountains in southwestern Arkansas, a small population of a *Hydrophyllum* was found on rocky, hardwood-forested bluffs along the Cosatot River (Howard County, 8 May 1979, R. Kral 63510). This was recorded and later again determined to be *H. macrophyllum* Nuttall. Checking the descriptions, statements on ecology, and distribution given in recent revisional work by Constance (1942) and Beckmann (1976, 1979) appeared to confirm the identification of the plant as *H. macrophyllum*, a species of the Central Plains and Appalachian provinces. Statements of range for *H. macrophyllum* as given by these two authors differ slightly, both showing a distribution of this mesophyte from the Central Lowlands of Illinois, Indiana, Ohio, southward through the Appalachians to western North Carolina in the east, and with western limits from southern Illinois southward through Kentucky, central Tennessee, and northern Alabama. However, Beckmann, in his citations of specimens, indicated an Arkansas record (1976: 366), "Arkansas. Montgomery Co.-Albert: rich woods, *Demaree* 36687 (GH)," the "Albert" given there ostensibly representing the Albert Pike Recreation Area or its vicinity in the Ouachita National Forest. Nonetheless, the Howard County find was thought to be a recent and unpublished record for Arkansas, and a check of Smith's (1978) atlas was made. According to Smith, the species had been reported for Arkansas by Dwight Moore as early as 1951, and there were currently five counties known for it. Thus the investigation ended, the Howard County specimen was routinely filed at the Vanderbilt University Herbarium (VDB), and the matter was forgotten.

Several years later, in 1988, another *Hydrophyllum* specimen from the Arkansas Ouachitas was brought in for determination (Bates 7557). This unicate was an eye-opener, particularly because, unlike the "top-snatched" Kral material, it had an intact rootstock containing a dense fascicle of small, fusiform, sweet-potato-like tubers, different from those produced by other known hydrophyllums. This feature, when combined with other less evident, but

nonetheless diagnostic floral and indumental ones, was enough to distinguish the Arkansas plant from other related species. We resolved to look further into the problem and are glad to report that the result was both exciting and confirmative.

We conducted field surveys for *Hydrophyllum* in the Ouachitas during May of 1989 and 1990, and have assembled a study set of 15 samples from seven Arkansas counties. Also, so as to place our discovery into taxonomic context, we reviewed materials of *Hydrophyllum* from within its taxonomic complex at the herbaria of Vanderbilt University (VDB), the Missouri Botanical Garden (MO), and Harvard University (selected GH material identified as *H. macrophyllum*). These aids are hereby gratefully acknowledged.

Remarkably, a sheet of "our" plant was discovered in the loan from MO, a further indication that the Arkansas plants were noticed by others a long time ago. The specimen, annotated as *H. macrophyllum* by Constance and Beckmann, is of two small plants in flower but both lacking the distinctive rootstock. It bears the sort of cryptic label information typical of its time, but the following is legible, namely, "Ark. G. E., 403, Mai 1837." Another single line is hardly legible but can be interpreted enough to make out that the collection was made from bottomland forests along the Saline River, and the script matches that of George Engelmann, who explored much of Missouri and Arkansas by horseback during that period. Thus, we think it is fitting that the holotype be accessioned at MO.

We name the new species *Hydrophyllum brownei* in honor of Edward T. Browne, Jr., Professor Emeritus of Biology, Memphis State University, accomplished floristician, an authority on Liliaceae, and a friend who has done much to increase our knowledge of the flora of eastern Arkansas, Kentucky, and western Tennessee.

***Hydrophyllum brownei*** Kral & Bates, sp. nov.

TYPE: United States. Arkansas: Polk Co., terraces and silty bottoms along Big Fork Creek at Opal, ca. 3 mi. N of Ark. Hwy. 8 and Big



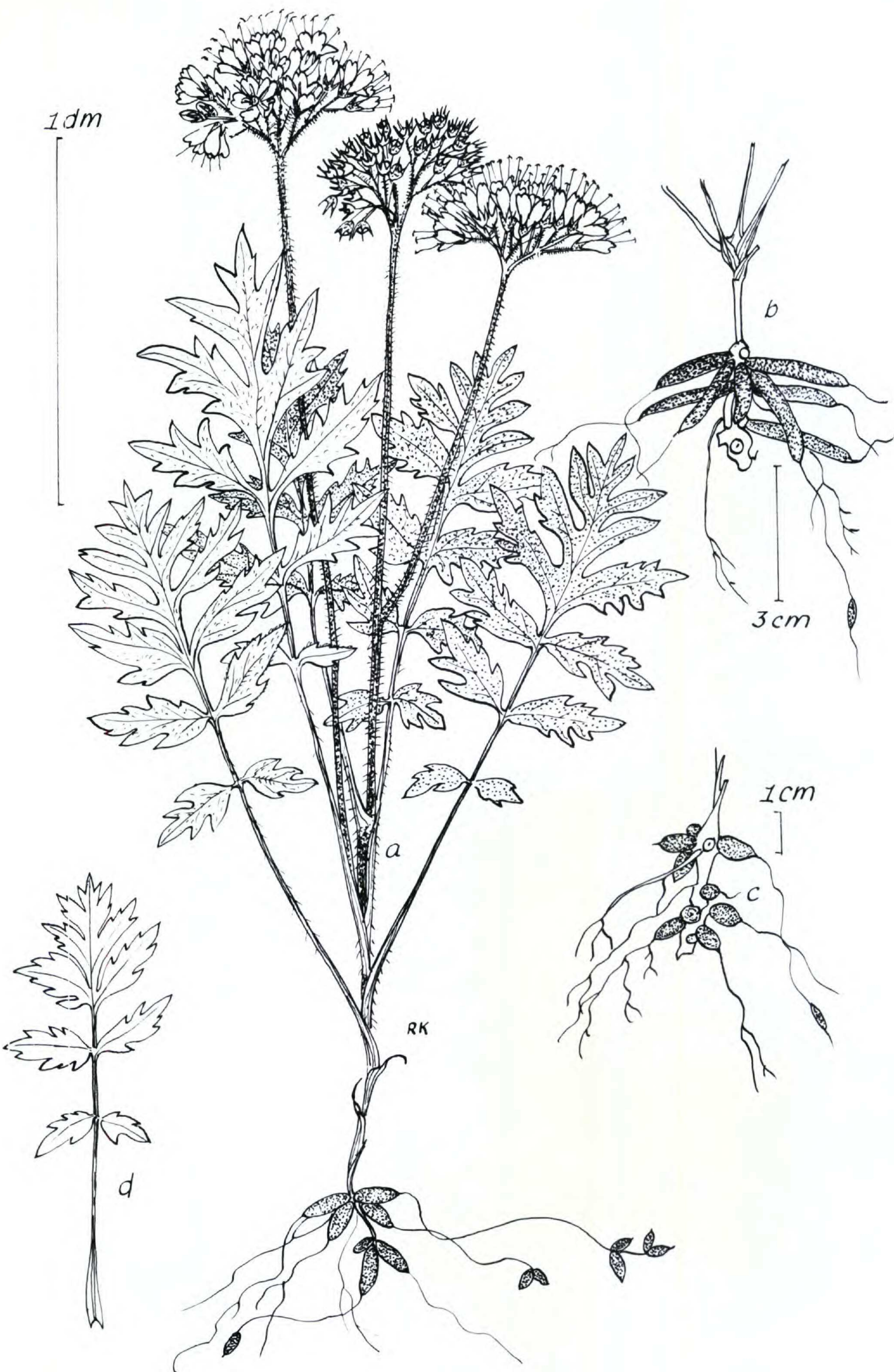


Figure 1. *Hydrophyllum brownei* Kral & Bates. — a. Habit sketch. — b. Plant base, rootstock. — c. Another rootstock morphology. — d. Early leaf.



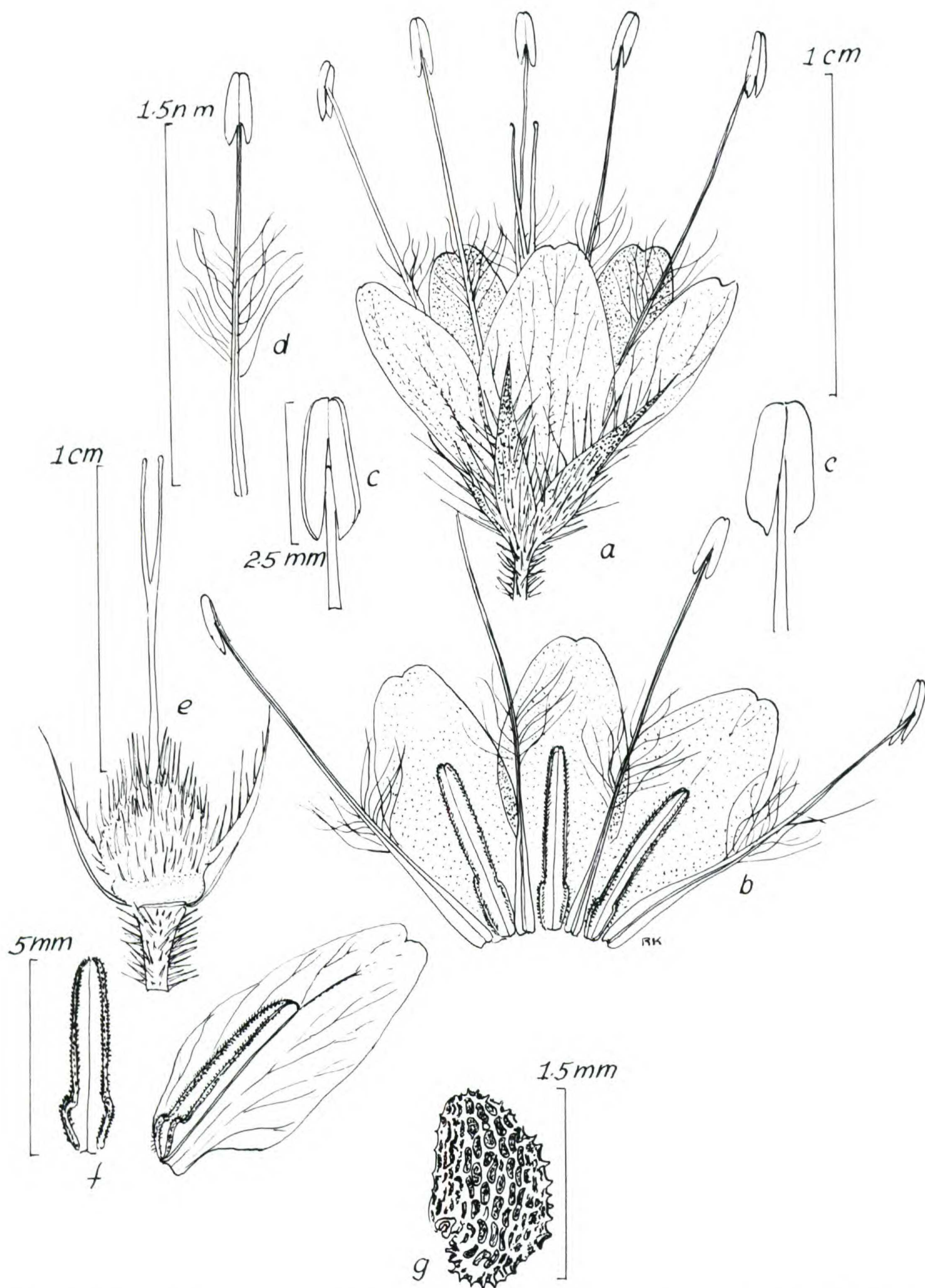


Figure 2. *Hydrophyllum brownei* Kral & Bates.—a. Side view of flower.—b. Spread portion of corolla showing three petals, four stamens, three appendages.—c. At left, adaxial view of anther; at right an abaxial view of same.—d. Stamen.—e. Gynoecium at anthesis, side view.—f. At left, a corolla appendage; at right, an oblique view of appendage as attached to petal.—g. Seed.



Fork, T2S, R28W, S28, SE1/4, 22 May 1989, R. Kral & V. Bates 76352 (holotype, MO; isotypes, F, GH, K, NY, RSA, SMU, TENN, UC, US, VDB). Figures 1, 2.

*Hydrophyllum brownei* Kral & Bates; species ex affinitate *H. occidentale* (Wats) Gray et *H. macrophyllum* Nutt., ab utroque tuberorum forma et proliferatio distincta.

The plant perennial, suberect, subrosulate, commonly 2–5 dm high, rhizomatous, strongly tuberiferous. Rhizome much contracted, suberect, irregularly thickened, the thickenings with fascicles of tubers and with elongate-fibrous roots, these often apically tuberiferous. Tubers ellipsoid to cylindric or fusiform, 5–30 mm long, 2–5 mm thick, producing fibrous roots apically (these in turn sometimes tuberiferous). Flowering stems mostly single, gradually contracted to base, there covered by lance-oblong, erect scale leaves 1–3 cm long, upstem thickened to 3 mm, purple, terete, striate, strigo-hirsute, often retrorsely so proximally. Principal foliage leaves lyrate-bipinnatifid, 1–4 dm long; petioles variously elongate, gradually thickened and dilated toward base, clasping; blades strigo-hirsute, elliptic to narrowly obovate, the upper surface dark green (white-mottled when young) and sparsely to densely strumose-strigose with hairs mostly less than 1 mm, the lower surface paler, densely strigose-hirsute with admixtures of hirtellous hairs, the vein intervals pilose-hirsute with hairs to 1.5 mm, frequently with a pilosulous admix; primary segment pairs 3–5, the lowest commonly deflexed and more distant, upblade increasingly confluent, margin coarsely pinnatifid, pinnate or serrate, strigo-ciliate. Inflorescences multiflorous, axillary, solitary or few (2–5), suberect, the cincinni compact to somewhat lax, 2–6 cm wide, multibranched, with branches and pedicels densely and palely hispidulous or hirtellous-tomentulose; peduncles terete, variously elongate, 2–3 mm thick, purplish, pilose-hirsute with progressive increase of shorter hairs up-peduncle, striate, strict or few-branched. Calyx at anthesis 5–7 mm long (after anthesis up to 10 mm), unappendaged, the lobes linear-triangular, green, coarsely strigo-ciliate, coarsely strigo-hispid; corolla rotate-funnelform, 10–12 mm long, to 13 mm wide, pale or bright lavender to near white, smooth or externally minutely hirtellous medially and at tips; stamens inserted at corolla base, filaments ca. 15 mm, tapering, pilose at middle, anthers dark purple, oblong, 2.5–2.7 mm long, extrorse, dorsifixed; corolla appendages narrowly oblong, auriculate, concave, 4.5–5.5 mm long, the margin slightly thickened, clammy-hirtellous; ovary broadly ovoid, ca. 2 mm high, densely setose-hirsute or strigo-hirsute from middle to tip, thick-

ened-annulate and smooth at base, the styles 9–10 mm long, the branches equaling the style base. Capsules broadly ovoid to subglobose, setose-hirsute, 3–3.5 mm long; seeds irregularly obtrigonus to ob-ovoid, 1–2 mm long, pale to deep brown, coarsely and sharply irregularly reticulate, the hilum basal-lateral.

*Paratypes.* UNITED STATES. ARKANSAS: Garland Co., gravel terraces, Mazarn Creek, Percy Quad, T3S, R22W, Center of Sect. 25; shade of bottomland hardwoods, 13 May 1990, Kral & Bates 77588 (GH, MO, NLU, NY, SMU, UARK, UC, VDB, WIS); Howard Co., rich hardwood bluffs by Ark. Hwy. 4, 9.6 mi. E of Wickes, 9 May 1979, Kral 63510 (MO, UARK, VDB); rocky shaded base of bluffs above Cossatot River at Ark. Hwy. 4 bridge, 23 May 1989, Kral & Bates with A. Pittman 76389 (VDB); Montgomery Co., silty sandy clay of gravelly alluvium, lower rocky slopes and rises, Caddo River ca. 4 mi. W of Norman near Mt. Gilead Church, T3S, R25W, SW quarter of Sect. 26, 12 May 1990, Kral & Bates 77542 (BM, CLU, F, GA, GH, KANU, MO, NCU, NY, OS, PAC, RSA, TEX, UARK, UC, VDB); bottoms near Buttermilk Springs, ca. 2 mi. NE of Ark. Hwy. 27 and Caddo Gap, T4S, R24W, Sect. 1, 12 May 1990, Kral & Bates 77554 (GH, MO, UC, VDB); sandy silty clay of bottoms along Howell Branch by Ark. Hwy. 27, 6.5 mi. S of Washita, 16 May 1990, Kral & Bates 77617 (MO, US, VDB); Pike Co., hardwood bottoms of Little Missouri River where crossed by Ark. Hwy. 84, E of Athens, ca. 4 mi. W of Langley, 15 May 1990, Kral 77613 (GH, K, MICH, MO, NCSC, NY, RSA, US, VDB); Polk Co., Big Fork State Natural Area, fairly common on moist ground along Big Fork Creek and in the open areas around the spring, 12 Apr. 1989, Bates 8890 (VDB—juvenile material); stream terraces along Big Fork Creek, Big Fork State Natural Area, 12 May 1988, Bates 7557 (VDB); Big Fork State Natural Area, R28W, T3S, Sect. 10, along Big Fork Creek, mesic wooded rocky bottom and N aspect slope, 22 May 1989, Kral & Bates 76330 (VDB). Topotype. 13 May 1990, Kral & Bates 77564 (AUA, BM, F, FLAS, FSU, GA, GH, IBE, K, KANU, LAF, MICH, MO, NCSC, NCU, NLU, NY, OS, PAC, RSA, SMU, TENN, TEX, UARK, UC, UNA, US, VDB, VSC); Sevier Co., hardwood bottoms along Cossatot River due E of King, W side, 15 May 1990, Kral 77601 (F, FSU, GA, GH, K, KANU, MICH, MO, NCU, NLU, NY, PAC, SMU, TENN, UC, VDB, VSC); Yell Co., sandy silty clay of mesic hardwood rises above Petit Jean River, S side of Ark. Hwy. 309 bridge, T5N, R25W, NE quarter of Sect. 15, Kral & Bates 77591 (GH, MICH, MO, NCSC, NLU, NY, SMU, US, VDB).

*Hydrophyllum brownei* is a mesic-woodland plant rooted in silt-loams or loams with a variable sand or clay fraction, and usually these soils are pocketed in talus of rich shaded slopes or the rocky, better-drained terraces along the Ouachita Mountain streams. It is, as are other eastern hydrophyllums, typically under rich deciduous forest, this mostly oak, elm, hackberry, maple, hickory, and ash. Its herbaceous associates are such common spring woodland elements as *Stellaria*, *Anemonella*, *He-*



TABLE 1. Comparison of habit, stem, branches of *H. occidentale*, *H. brownei*, and *H. macrophyllum*.

	<i>H. occidentale</i>	<i>H. brownei</i>	<i>H. macrophyllum</i>
Plant height	1–6 dm	1–5 dm	2–9 dm
Rootstock	Rhizome irregularly thickened, horizontal to erect	Rhizome erect or ascending, irregularly thickened	Rhizome irregularly thickened, horizontal to erect
Roots	Fascicled, the larger ones cylindric or linear-fusiform, 5–10 cm long	Fascicled, ellipsoid, short-cylindric, 0.5–3 cm long, the tubers typically producing whiplike tips, these spreading to 1 m, often repeatedly tuberiferous	Fascicled from thickened nodes, the larger ones cylindric or linear-fusiform to narrowly claviform, 5–10 cm long, these with slender tips to 10 cm, rarely proliferating
Stem and peduncle	Lower stem erect or ascending, caudiciform and sheathed by old leaf scales and bases and comparatively thick	Lower stem tapering directly to uppermost fascicle of tubers, slender, often elongate, crowned by rosette of approximate leaves	Lower stem erect or ascending, caudiciform, and sheathed by scales and old leaf bases, comparatively thick
	Aerial stem proximally (and petiole bases there) sparingly to copiously, usually retrorsely puberulent, hirsute, hirtellous or strigo-hirsute, or with admixtures of these hairs, particularly on the nerves or ribs. Upstem and on peduncles mostly more spreading, with higher percentage of shorter softer hair. Peduncle apex and branches increasingly tomentulose, hispid, pilose or hirtellous	Aerial stem proximally (and petiole bases there) sparingly to copiously, mostly retrorsely strigo-hirsute, often an admix of shorter strigillose or hirtellous pubescence, particularly on nerves and ribs. Upstem and on peduncles essentially the same or with short hairs admixed. Peduncle apex and branches increasingly tomentulose, hispid, hirsute or hispidulous	Aerial stem proximally (and petiole bases there), moderately to densely, mostly retrorsely hispid-hirsute or strigo-hirsute, also often hirtellous, hispidulous and/or strigillose, particularly on nerves and ribs. Upstem and on peduncle hairs more spreading, often mixed with finer hairs. Peduncle apex and branches increasingly tomentulose, often also sparsely hirsute
Pedicels	Puberulous with sparse admix of hirsute hairs	Puberulous with admix of hirsute hairs	Densely puberulous with admix of hirsute hairs
Principal leaves	Blade prevalently oblong or elliptic-oblong; segments 9–13, mostly ovate or elliptic, coarsely low-toothed or pinnatifid, most pairs separated by wingless rachis, lower 1–2 pairs with short petiolules or with narrowed base 2–4 mm across	Blade prevalently oblong to elliptic-oblong; segments 9–11(13), mostly ovate or elliptic-oblong, coarsely low-toothed or pinnatifid, most pairs with narrow wing-confluence, the lowest 1–few pairs not connected by wing-rachis, narrowed to short petiolules or with narrowed base 2–3 mm across	Blade oblong, elliptic or narrowly ovate; segments 9–11(13), mostly oblong, coarsely low-toothed, all or all but lowest 1(2) pairs confluent by broad rachis wing, the lower pairs connected by narrow rachis wings, usually 5–15 mm across base
Leaf—upper surface	Uniformly sparsely to copiously strigose or strigose and strigillose, no hairs longer than 1 mm	Uniformly sparsely to copiously strigose-strigillose, no hairs longer than 1 mm, most 0.5–0.8 mm long	Uniformly sparsely to copiously strigose or strigose-strigillose, longer hairs 1–1.5 mm long



TABLE 1. Continued.

	<i>H. occidentale</i>	<i>H. brownei</i>	<i>H. macrophyllum</i>
Leaf—lower surface	Hirsute to pilose or pilosulous on veins, pilose, hirtellous, often tomentulose between veins, most hairs under 1 mm (except some Oregon and California specimens)	Sparsely to moderately hirsute on veins, strigose, strigillose or hirtellous between veins. Hairs rarely to 1 mm	Moderately to copiously hispid, hirsute, also often hirtellous on veins (longest hairs 1–2 mm long), hirtellous to strigillose or strigose between (longer hairs mostly 1.0 mm often less than 0.5 mm)
Calyx	Accrescent, coarsely hispid-ciliate, at anthesis free to near base, lobes oblong, rounded, backs finely pubescent medially and distally	Accrescent, coarsely hispid-ciliate, at anthesis free to near base, lobes narrowly and abruptly triangular-acuminate, 4.5–7 mm, backs strigo-hispid proximally, strigillose distally	Accrescent, coarsely hispid-ciliate, at anthesis $\frac{2}{3}$ free, lobes abruptly narrowly acuminate, 5–7 mm, backs densely tomentulose, also sparsely hispid-hirsute
Corolla	7–10 mm long, lavender to near white, lobes oblong, rounded, backs finely pubescent medially and distally	10–12 mm long, lavender to near white, lobes oblong-ovate, rounded or shallowly emarginate, backs finely, often sparsely, pubescent medially and distally	7–10(12) mm long, greenish white to yellowish white, lobes oblong, rounded or shallowly emarginate, backs densely puberulent

*patica*, *Sanguinaria*, *Arabis*, *Viola*, *Cardamine*, *Asarum*, *Geranium*, *Polemonium*, *Osmorrhiza*, *Thaspium*, *Zizia*, *Galium*, *Hedyotis*, *Senecio*, along with many carices, grasses, and woodland ferns.

As the habit sketch shows (Fig. 1), this plant is remarkably well adapted to the rocky detritus in which it roots. The lower stem arises variously from the tuberiferous upper rhizomal crown and can wind its slender way up between the rocks and gravel fragments, the leaves at this level scalelike and erect; then, at substrate surface and above are presented the principal leaves, the lowest of which are usually longest-petioled, most approximate, and with the most segments. Below this upper rhizomal crown, slender rhizomal internodes are displayed alternating with thickened, tuberiferous older rhizomal crowns, the number of these downward along the axis being an indication of the plant age. All tubers at the different levels are capable of producing elongate, flagelliform roots apically, these winding their way outward through the rock jumble to as much as a meter, and in turn emitting small tubers at their tips. Such a trait allows for exceptionally active cloning, as small tubers doubtless detach as propagules within the shifting or eroding, sloping substrate or in the periodically flooding, rocky, second bottoms.

Constance (1942), the acknowledged authority on *Hydrophyllum*, notes the genus as a small, exclusively North American group of eight species of bicentric distribution with four species in mesic situations in the east and four in mesic to somewhat xeric situations in the western cordilleras. Beckmann (1976, 1979), in his more recent and biosystematic assay of the genus, adopted this same taxonomy and geography and discussed at considerable length the vicarious nature of *Hydrophyllum*. He stated (1976: 1), “No single species occurs in both centers, but the genus includes two different pairs of closely related species, vicariads, one member of each pair being represented either in the eastern or western area.” He is referring to the strong overlap in character states within the *H. tenuipes*–*H. virginianum* pair and in the *H. macrophyllum*–*H. occidentale* pair. It is the latter vicariad with which we deal, as these two, like *H. brownei*, are caulescent with basal and cauline leaves similar, are hairy-stemmed-and-scaped, have pinnatifid leaves with the principal segments obtuse or abruptly acute with blunt or abruptly acute marginal teeth or lobes, and have comparatively compact cymes. Within the vicariad, *H. occidentale* has the most deeply divided calyx, the softer pubescence overall, and the shorter as well as softer petiolar hair.



At this point it should be mentioned that, particularly within the vicariads, floral and trichomal characters have homologous expression, as is made plain when species are compared by means of table or conventional keys. Constance (1942) and Beckmann (1976, 1979) stress this and agree that the taxonomy of the perennial species must emphasize vegetative features, as do we. Thus, taking into account such qualifiers, we present a table (Table 1) in which character states of the new species are compared with those of *H. occidentale* and *H. macrophyllum*. The reader will note that several features (i.e., androecium, gynoecium, fruit, and seed features) are not compared, as overlapping limits of variation in these make such comparisons nearly useless.

The table reveals that *H. brownei* indeed stands apart as to character of roots and rootstock, and that it most closely resembles *H. occidentale* in leaf and leaflet shape, in indumental character of leaf and stem, in degree of sepal connation, in petal form and pigmentation as well as pubescence. However, it is difficult to interpret some specimens of *H. occidentale* from the Willamette Valley of Oregon and from southern Oregon and northern California as to leaf trichomes, these and sometimes also the leaflets being uncomfortably similar to those of *H. macrophyllum*. The table also shows that the new species trends toward *H. macrophyllum* as to some trichomal features (overall coarser) and shape and size of calyx lobes. We have not seen living specimens of *H. occidentale* but note from specimens, photographs, and illustrations that *H. brownei* resembles it far more than does its closer neighbor, *H. macrophyllum*.

When one examines distribution maps for the *H. occidentale*, *H. brownei*, and *H. macrophyllum*, showing the three allopatric loci from the more recent western cordilleran systems that contain *H. occidentale*, and the two older physiographic eastern provinces that support *H. brownei* and *H. macrophyllum*, respectively, it becomes possible to construct a reasonable hypothesis for origin of this vicariad, as did Beckman and other workers before him. The best explanation appears to be that there was a continuous and nearly transcontinental distribution of ancestral stock, which over time and because of geologic and climatic shift became discontinuous. The greatest clinal range is expressed by *H. occidentale*, not suprisingly as this species occupies at once the greatest area and the most diverse ecology. Interestingly, the most eastern material of that plant shows the most resemblance to populations of *H. brownei*.

We still have some follow-up work to do. There are sight records of *Hydrophyllum* arbitrarily determined as *H. macrophyllum* from areas north of the Ouachitas in Arkansas. We know that the few old records from that complex that were gotten by Engelmann and Demaree from the Ouachita trend are indeed *H. brownei*, but we still have to locate and determine those northern records, which, if indeed turn out to be *H. macrophyllum*, would constitute the only records of the latter from west of the Mississippi. Also, we do not yet have chromosomal information; but as all other known hydrophyllums have been found to have haploid complements of 9, there is some measure of confidence that *H. brownei* is the same. Also of interest is the fact that the Ouachita Mountains of Arkansas and contiguous Oklahoma are remarkably high in recently described endemics and may well be the most suprising floristic area within the Interior Highlands physiographic province. To name some that have been described in recent decades one can include graminoids such as *Carex latebracteata* Waterfall, *C. ouachitana* Kral, Bryson & Manhart, *Calamovilfa arcuata* K. Rogers (bicentric, with one locus in the Tennessee Cumberlands, the other the Ouachitas) and other species such as *Streptanthus squamiformis* Goodman, *Amorpha ouachitensis* Wilbur, *Monarda stipitatoglandulosa* Waterfall, *Hedyotis ouachitana* E. B. Smith, *Polymnia cossatotensis* Pittman & Bates, and *Solidago ouachitensis* Taylor & Taylor.

At present, it appears that *H. brownei* is the only species of its genus to be found within the Ouachita Mountains Natural Division, and as such it poses some interesting phytogeographic questions as to the nature of vicariads in that genus. As we now have several localities for the species within protected areas of the Ouachita National Forest, it is reassuring to know that it stands in little danger of extirpation.

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